NOBLE GASES, COSMIC RAY EXPOSURE AGES AND PAIRING OF H3-CHONDRITES FROM THE SAHARA.

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Thirty-eight Saharan H3-chondrites have been studied to compare their distribution of cosmic ray exposure ages with that of H-chondrite falls and finds. Another aspect is to solve the pairing problem for these hot desert samples with the help of characteristic noble gas signatures like solar gas contribution, radiogenic ^{4}He and ^{40}Ar, cosmogenic nuclides and deficits of ^{3}He. We present new noble gas data for 26 H3-chondrites and data for 12 H3-chondrites taken from the literature [1, 2]. This covers all currently known meteorites of this type from the Sahara. Furthermore, we provide suggestions for paired specimens taking into consideration noble gas data, petrographic-chemical classifications, weathering grades, shock classifications and find locations of the meteorites.

Samples: According to [3], [4] and [5], 38 classified H3-chondrites were found between 1986 and 1995 in various parts of North African desert areas. Their petrologic types range from unequilibrated H3-chondrites to H3-6 breccias. Most of the samples were collected in Algeria, particularly in the Acfer region (28), but also in El Atchane (1), Ilafegh (1) and Tanezrouft (2). Six of the samples were found in the Hammadah al Hamra (3) and Daraj area (3) in Libya.

Sampling and Analytical Methods: All samples were taken at least 5 mm from the fusion and/or weathering crust. The fragments were preheated in vacuum for at least 48 hours at 140ºC to remove any lightly bound atmospheric gases. Isotopic composition and abundances of He, Ne and Ar as well as the concentrations for ^{84}Kr, ^{129}Xe and ^{132}Xe were determined with the MAP 215 mass spectrometer system "Alfred" on bulk samples (sample weight ~ 100 mg). A detailed description of the apparatus and the experimental procedures is given in [6].

Results and Discussion: The results for 31 of the 38 H3-chondrites are summarized below. A complete list will be available at the time of the LPSC XXVIII.

The **cosmic ray exposure ages** are derived using production rates and shielding corrections given by [7], but with ^{38}Ar production rates reduced by 13% [8]. We consider the ^{21}Ne exposure ages (T$_{21}$) as the most reliable ages because ^{3}He is often affected by diffusive loss due to heating events as meteoroids and the uncertainty for T$_{38}$ is high in case of large corrections for trapped argon. In addition, ^{38}Ar is more influenced in hot desert meteorites by terrestrial weathering than ^{3}He and ^{21}Ne [9, 10]. Thus, T$_{21}$ ages are used for comparisons. Uncertainties for calculated

exposure ages are estimated to be less than 15%. For Acfer 111 we adopt an average value of 15 measurements of solar-gases-poor clasts, i.e. 37.6 Ma [11]. The histogram in **Fig.1** shows that the age distribution is comparable with that of H-chondrite falls and finds. The ages range from 2.1 Ma (Ilafegh 013) to 39.2 Ma (Acfer 188) with a clustering of samples at ~ 4 Ma, ~ 12 Ma and between 20 Ma and 40 Ma. The latter is consistent with the observations by [12] which show that a ~ 33 Ma peak is prominent particularly for H3-chondrites. Only three Saharan chondrites cluster close to the dominant 7 to 8 Ma peak of all H-chondrite falls and finds.

Twelve of the specimens (Acfer 006, Acfer 111, Acfer 153, Acfer 162, Acfer 163, Acfer 166, Acfer 180, Acfer 192, Acfer 200, Acfer 204, Acfer 259, Ilafegh 013) contain **solar gases** (^{20}Ne/^{22}Ne > 1.5) and are regolith breccias. They represent at least 10 individual falls. The largest amounts of solar gases were measured in Acfer 111, with ^{20}Ne/^{22}Ne > 11 [2, 11].

A **deficit of ^{3}He** generally indicates a loss of helium due to elevated temperatures in space. This occurs in meteoroids which have orbits with small perihelion distances. However, terrestrial weathering can also lead to a depletion of light noble gases [9, 10]. Seven H3-chondrites are characterized by a significant loss of ^{3}He: Acfer 005, Acfer 022, Acfer 119, Acfer 159, Acfer 237, Acfer 259 and Acfer 129. Pairing is suggested for Acfer 022 and Acfer 237 as well as for Acfer 119 and Acfer 159.

Thermal and shock events in the meteorites history alter the content of **radiogenic gases**. Only Acfer 022, Acfer 237 and Ilafegh 013 have experienced a considerable loss of ^{4}He$_{rad}$ (^{4}He < 500 × 10^{-8} cm^3 STP/g), which is also correlated with a ^{3}He deficit. A pronounced deficit of ^{40}Ar$_{rad}$ (^{40}Ar < 2500 × 10^{-8} cm^3 STP/g) is only observed in Ilafegh 013. Most Saharan H3-chondrites have retained most of their radiogenic gases.

It has been shown that meteorites from hot desert areas contain large amounts of **trapped heavy noble gases** [10]. An indicator for the atmospheric contribution due to weathering is a high ^{84}Kr/^{132}Xe ratio, compared to the low planetary value of about 0.5. All samples except Acfer 188 are characterized by excess of ^{84}Kr with ^{84}Kr/^{132}Xe ratios between 1 and 8.

With the help of the characteristic noble gas fingerprint, the petrographic-chemical classification and the knowledge of the precise find location, it is

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possible to provide suggestions for paired samples. As a preliminary result, we estimate about 80% of the so far investigated specimens to be individual falls.

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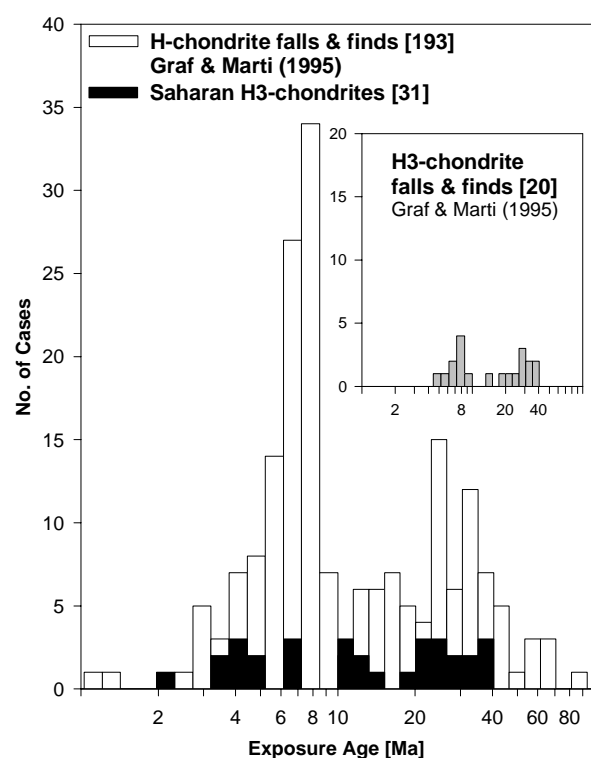

Fig.1 Distribution of cosmic ray exposure ages of Saharan H3-chondrites compared to that of all H-chondrite falls and finds (pairing not considered). The cluster between 20 Ma and 40 Ma is also characteristic for H3-chondrite falls and finds. The age scale is logarithmic with 15% age resolution which corresponds to the estimated uncertainties.